DEFENSE INFORMATION SYSTEMS AGENCY
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IN REPLY REFER TO: Joint Interoperability Test Command (JTE) **6 Aug 12**

MEMORANDUM FOR DISTRIBUTION

SUBJECT: Special Interoperability Test Certification of the Cisco 3900E Series with Internetwork Operating System (IOS) 15.1(4)M3

References: (a) DoD Directive 4630.05, "Interoperability and Supportability of Information Technology (IT) and National Security Systems (NSS)," 5 May 2004
(b) CJCSI 6212.01E, "Interoperability and Supportability of Information Technology and National Security Systems," 15 December 2008
(c) through (e), see Enclosure 1

1. References (a) and (b) establish the Defense Information Security Agency (DISA) Joint Interoperability Test Command (JITC), as the responsible organization for interoperability test certification.

2. The Cisco 3945E with IOS 15.1(4)M3 is hereinafter referred to as the System Under Test (SUT). The SUT meets all of its critical interoperability requirements for joint use within the Defense Information System Network (DISN) as a High Availability Customer Edge Router (CER). When a CER meets the High Availability CER requirements, it is also certified as a Medium Availability with System Quality Factors (SQF), Medium Availability without SQF, and Low Availability CER. The SUT met the High Availability and Medium Availability with SQF CER requirements in a dual-chassis configuration. The SUT met the critical interoperability requirements set forth in Reference (c), using test procedures derived from Reference (d). The SUT met the critical interoperability requirements for the following Wide Area Network (WAN) interfaces: Institute of Electrical and Electronics Engineers (IEEE) 802.3i (10BaseT), IEEE 802.3u (100BaseT), European Multiplex Rate 3 (E3), Digital Signal Level (DS)1, DS3, and Electronic Industries Alliance (EIA)-530. The SUT also met the critical interoperability requirements for the following Assured Services Local Area Network (ASLAN) interfaces: IEEE 802.3i (10BaseT), IEEE 802.3u (100BaseT), and IEEE 802.3ab (1000BaseT). The Cisco 3925E employs the same software and similar hardware as the SUT. JITC analysis determined this system to be functionally identical to the SUT for interoperability certification purposes and therefore, it is also certified for joint use. No other configurations, features, or functions, except those cited within this memorandum, are certified by JITC. This certification expires upon changes that could affect interoperability, but no later than three years from the date of the Unified Capabilities (UC) Approved Products List (APL) memorandum.

3. This finding is based on interoperability testing conducted by JITC, review of the vendor's Letters of Compliance (LoC), DISA adjudication of open test discrepancy reports (TDRs), and

DISA Certifying Authority (CA) Recommendation of the Information Assurance (IA) configuration. Interoperability testing was conducted by JITC, Fort Huachuca, Arizona, from 2 April through 1 May 2012. Review of the vendor's LoC was completed on 12 June 2012. DISA adjudication of outstanding TDRs was completed on 10 July 2012. The DISA CA provided a positive Recommendation on 30 May 2012 based on the security testing completed by DISA-led IA test teams and published in a separate report, Reference (e). The acquiring agency or site will be responsible for the DoD Information Assurance Certification and Accreditation Process (DIACAP) accreditation. Enclosure 2 documents the test results and describes the tested network and system configurations including specified patch releases.

4. The interface, Capability Requirement (CR) and Functional Requirement (FR), and component status of the SUT are listed in Tables 1 and 2. The threshold CR/FRs for CERs are established by Section 5.3.2.14 of Reference (c) and were used to evaluate the interoperability of the SUT. Enclosure 3 provides a detailed list of the interface, capability, and functional requirements.

Table 1. SUT Interface Interoperability Status

Interface	Critical	UCR Reference	Threshold CR/FR (See note.)	Status	Remarks
ASLAN Interfaces					
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000BaseT) interface.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
WAN Interfaces					
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
DS1	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
DS3	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
E1	No	5.3.2.14.9	1-2	Not Tested	This interface is supported; however, it was not tested and is not required.
E3	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
EIA-530	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
OC-X	No	5.3.2.14.9	1-2	Not Tested	This interface is not supported and is not required.
Network Management Interfaces					
10Base-X	Yes	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.4 5.3.2.14.9	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000BaseT) interface.

Table 1. SUT Interface Interoperability Status (continued)

NOTE: The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3. The system under test does not need to provide conditional requirements. However, if a capability is provided, it must function according to the specified requirements.

LEGEND:

802.3ab	1000BaseT Gbps Ethernet over twisted pair at 1 Gbps (125 Mbps)	EIA	Electronic Industries Alliance
802.3i	10BaseT Mbps over twisted pair	EIA-530	Standard for 25-position interface for DTE and DCE employing serial binary data interchange
802.3u	Standard For Carrier Sense Multiple Access With Collision Detection At 100 Mbps	FR	Functional Requirement
ASLAN	Assured Services Local Area Network	Gbps	Gigabits per second
CR	Capability Requirement	IEEE	Institute of Electrical and Electronics Engineers
DCE	Data Circuit-Terminating Equipment	LoC	Letter of Compliance
DS1	Digital Signal Level 1 (1.544 Mbps)	Mbps	Megabits per second
DS3	Digital Signal Level 3	OC	Optical Carrier
DTE	Data Terminal Equipment	SUT	System Under Test
E1	European Digital Multiplex Rate (2.048 Mbps)	UCR	Unified Capabilities Requirements
		WAN	Wide Area Network

Table 2. SUT CRs and FRs Status

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
Product Interface Requirements					
1	Internal Interface Requirements	Required	5.3.2.4.1	Met	The SUT met all critical CRs and FRs.
	External Physical Interfaces between Network Components	Required	5.3.2.4.2	Met	The SUT met all critical CRs and FRs.
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2.12 para 1	Met	The SUT met all critical CRs and FRs.
	DSCP	Required	5.3.3.3.2	Met	The SUT met all critical CRs and FRs.
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3	Met	The SUT met all critical CRs and FRs.
	Traffic Conditioning Requirements	Required	5.3.3.3.4	Met	The SUT met all critical CRs and FRs.
CER Requirements					
2	Traffic Conditioning	Required	5.3.2.14.1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Support	Required	5.3.2.14.2	Met	The SUT met all critical CRs and FRs.
	Per Hop Behavior Support	Required	5.3.2.14.3	Met	The SUT met all critical CRs and FRs.
	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4	Not Tested	The SUT does not support this feature and it is not required.
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5	Not Tested	The SUT does not support this feature and it is not required.
	Availability	Required	5.3.2.14.7	Met	The SUT met all critical CRs and FRs. The SUT met High Availability CER requirements.[2]
	Packet Transit Time	Required	5.3.2.14.8	Met	The SUT met all critical CRs and FRs.
	CER Interfaces and Throughput Support	Required	5.3.2.14.9	Met	The SUT met all critical CRs and FRs.
	Assured VVoIP Latency	Required	5.3.3.4.1	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Latency	Required	5.3.3.4.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.5	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Jitter	Required	5.3.3.5.4	Met	The SUT met all critical CRs and FRs.[3]

Table 2. SUT CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
CER Requirements (continued)					
2	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4	Met	The SUT met all critical CRs and FRs.[3]
	End-to-End Availability	Required	5.3.3.12.1	Met	The SUT met all critical CRs and FRs.[3]
	Availability Design Factors	Required	5.3.3.12.2	Met	The SUT met all critical CRs and FRs.[3]
	Product Quality Factors	Required	5.3.3.12.3	Met	The SUT met all critical CRs and FRs.[3]
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1	Met	The SUT met all critical CRs and FRs.[3]
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2	Met	The SUT met all critical CRs and FRs.[3]
	Provisioning	Required	5.3.3.13	Met	The SUT met all critical CRs and FRs.[3]
	IP Routing Protocols	Required	5.3.3.14	Met	The SUT met this requirement with Static Routing, BGP-4, IS-IS, OSPFv2, OSPFv3, and VRRP.
	Voice Grade of Service	Required	5.3.3.15	Met	The SUT met all critical CRs and FRs.[3]
	Survivability	Required	5.3.3.16	Not Tested	This is an E2E engineering requirement and is not testable in a lab environment.[4]
IPv6 Requirements					
3	IPv6	Required	5.3.3.10	Met	The SUT met all critical CRs and FRs.
	Product Requirements	Required	5.3.5.4	Met	The SUT met all critical CRs and FRs with the following minor exception: The SUT does not support the following RFCs 4301 and 4303.[5]
NM Requirements					
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by the vendor's LoC.
	NM Requirements for CERs	Required	5.3.2.18.1	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by the vendor's LoC.
	NM	Required	5.3.2.14.6	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by testing and the vendor's LoC.

NOTES:
1. The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3.
2. If a CER meets the High Availability CER requirements, it meets all of the lesser requirements for Medium Availability with and without SQF and Low Availability. The Cisco 3945 meets the High Availability with a dual-chassis configuration. The Cisco 3925 CER was not tested; however, it employs the same software and similar hardware as the Cisco 3945. JITC analysis determined this system to be functionally identical to the 3945 for interoperability certification purposes and therefore, is also certified for joint use.
3. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.
4. This requirement was verified in an operational emulated environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in UCR Section 5.3.3.
5. The vendor submitted an IPv6 LoC with the following noted discrepancy: The SUT does not support RFCs 4301 and 4303. DISA adjudicated this deficiency as minor because this RFC addresses requirements for IPSec, which is an optional requirement and is not implemented in the certified configuration.

Table 2. SUT CRs and FRs Status (continued)

LEGEND:

BGP	Border Gateway Protocol	LoC	Letters of Compliance
CE	Customer Edge	LSC	Local Session Controller
CER	Customer Edge Router	MFSS	Multifunction Softswitch
CR	Capability Requirement	NM	Network Management
DSCP	Differentiated Services Code Point	NMS	Network Management System
E2E	End-to-End	POA&M	Plan of Actions and Milestones
FR	Functional Requirement	RFC	Request for Comments
IAW	in accordance with	OSPF	Open Shortest Path First
ID	Identification	SQF	System Quality Factors
IP	Internet Protocol	SUT	System Under Test
IPv6	Internet Protocol version 6	UCR	Unified Capabilities Requirements
IS-IS	Intermediate System-Intermediate System	VRRP	Virtual Router Redundancy Protocol
JITC	Joint Interoperability Test Command	VVoIP	Voice and Video over Internet Protocol

5. No detailed test report was developed in accordance with the Program Manager's request. JITC distributes interoperability information via the JITC Electronic Report Distribution (ERD) system, which uses Unclassified-But-Sensitive Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program (STP). STP is accessible by .mil/gov users on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents and references are on the JITC Joint Interoperability Tool (JIT) at http://jit.fhu.disa.mil (NIPRNet). Information related to DSN testing is on the Telecom Switched Services Interoperability (TSSI) website at http://jitc.fhu.disa.mil/tssi. Due to the sensitivity of the information, the Information Assurance Accreditation Package (IAAP) that contains the approved configuration and deployment guide must be requested directly through government civilian or uniformed military personnel from the Unified Capabilities Certification Office (UCCO), e-mail: disa.meade.ns.list.unified-capabilities-certification-office@mail.mil.

6. The JITC point of contact is Mr. Edward Mellon, DSN 879-5159, commercial (520) 538-5159, FAX DSN 879-4347, or e-mail to edward.a.mellon.civ@mail.mil. JITC's mailing address is P.O. Box 12798, Fort Huachuca, AZ 85670-2798. The Tracking Number for the SUT is 1116702.

FOR THE COMMANDER:

3 Enclosures a/s

for RICHARD A. MEADOR
Chief
Battlespace Communications Portfolio

JITC Memo, JTE, Special Interoperability Test Certification of the Cisco 3900E Series with Internetwork Operating System (IOS) 15.1(4)M3

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ADDITIONAL REFERENCES

(c) Office of the Assistant Secretary of Defense, "Department of Defense Unified Capabilities Requirements 2008, Change 3," September 2011
(d) Joint Interoperability Test Command, "Unified Capabilities Test Plan (UCTP)," Draft
(e) Joint Interoperability Test Command, "Information Assurance (IA) Assessment of Cisco 3900E Release (Rel.) 15.1(4)M3 (Tracking Number 111670E)," Draft

CERTIFICATION TESTING SUMMARY

1. SYSTEM TITLE. The Cisco 3900E Series with Internetwork Operating System (IOS) 15.1(4)M3; hereinafter referred to as the System Under Test (SUT).

2. SPONSOR. Headquarters United States Army Information Systems Engineering Command (HQUSAISEC), Mr. Jordan R. Silk, USAISEC ELIE-ISE-ES, Building 53301, Fort Huachuca, Arizona 85613, e-mail: jordan.r.silk.civ@mail.mil.

3. SYSTEM POC. M. K. Whitlock, Cisco Systems, Inc., 170 West Tasman Drive, San Jose, California 95134, e-mail: mhitloc@cisco.com.

4. TESTER. Joint Interoperability Test Command (JITC), Fort Huachuca, Arizona.

5. SYSTEM DESCRIPTION. The Unified Capabilities Requirements (UCR) defines a Customer Edge Router (CER) as a router located at the boundary between the Edge segment and the Access segment of the Wide Area Network (WAN). The CER provides traffic conditioning, bandwidth management on a granular service class (i.e., voice, video) basis, and quality of service using per hop behaviors. A Base/Post/Camp/Station (B/P/C/S) may have a single CER or multiple CERs based on the local architecture. The SUT is an intelligent unified communications network border element. Perimeter routers are components used for scaling unified communications networks from being "Internet Protocol (IP) islands" within a single customer network to becoming an end-to-end IP community.

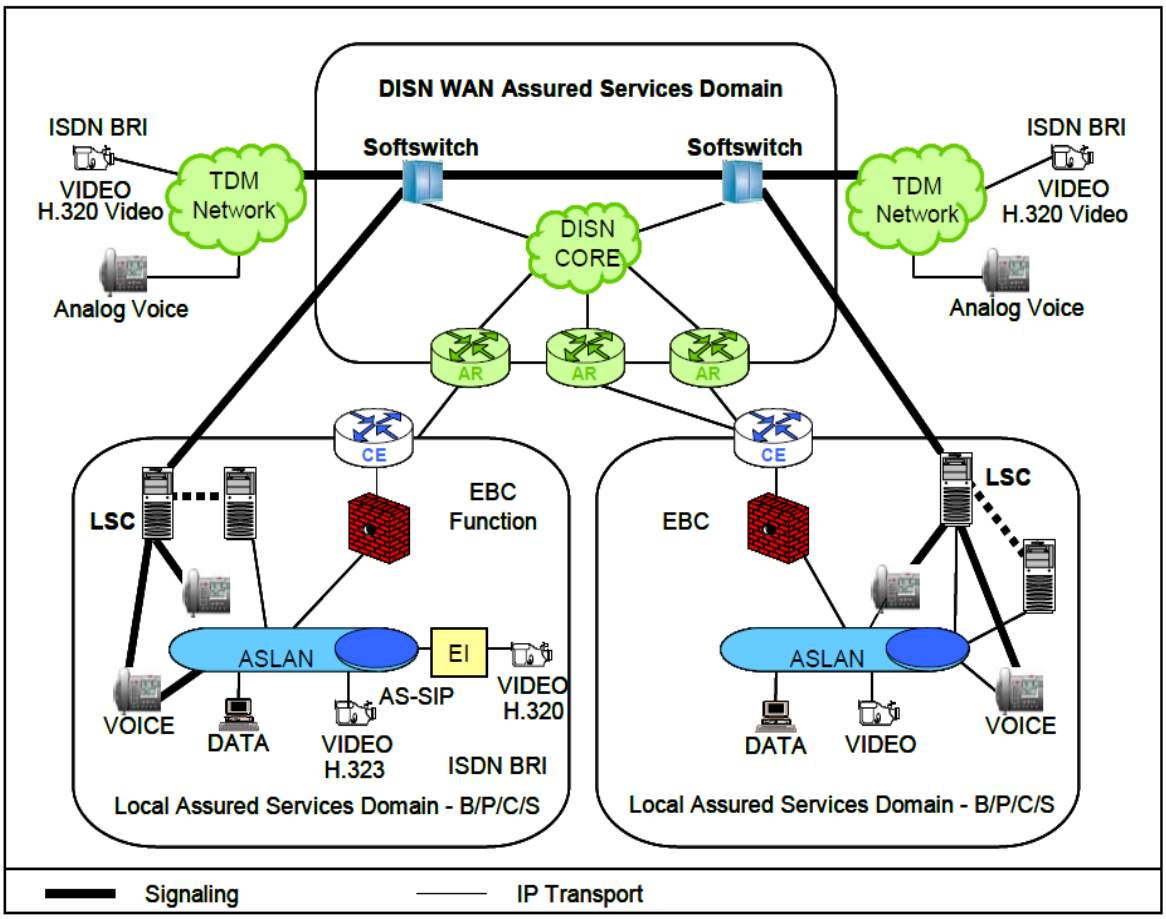
The SUT provides Customer Edge Routing capability for the Real Time Services (RTS)/Unified Capabilities (UC) Architecture. As a CER, the Cisco 3945E Router will be located at the boundary between the Edge and Access Segments. The Cisco 3945E will provide traffic conditioning; bandwidth management and Quality of Service (QoS) based on the RTS requirements. This includes granular definition of service classes for voice; video and other defined RTS Unified Capabilities.

a. SUT High Availability. The SUT is a High Availability solution in a dual-chassis configuration (redundant RE, fabric, and power) with no single point of failure.

b. SUT Medium Availability. If a CER meets the High Availability CER requirements, it meets all of the lesser requirements for Medium Availability with and without System Quality Factors (SQF). The SUT is a Medium Availability with SQF solution in a dual-chassis configuration (redundant RE, fabric, and power) with no single point of failure. The SUT Medium Availability solution does not require redundancy and is met with a single chassis.

c. SUT Low Availability. The Low Availability solution does not require redundancy and is met with a single chassis.

6. OPERATIONAL ARCHITECTURE. Figure 2-1 depicts the Defense Information System Network (DISN) Unified Capabilities notional operational architecture that the SUT may be used in.



LEGEND:

AR	Aggregation Router
ASLAN	Assured Services Local Area Network
AS-SIP	Assured Services – Session Initiation Protocol
B/P/C/S	Base / Post / Camp / Station
BRI	Basic Rate Interface
CE	Customer Edge (CE Router)
DISN	Defense Information System Network
EBC	Edge Boundary Controller
EI	End Instrument
H.320	ITU-T Standard for narrowband VTC
H.323	ITU-T Standard for multi-media communications on packet-based networks
IP	Internet Protocol
ISDN	Integrated Services Digital Network
ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
LSC	Local Session Controller
TDM	Time Division Multiplex
VTC	Video Teleconferencing
WAN	Wide Area Network

Figure 2-1. DISN Unified Capabilities Notional Operational Architecture

7. INTEROPERABILITY REQUIREMENTS. The interface, Capability Requirements (CR) and Functional Requirements (FR), and other requirements for CERs are established by Section 5.3.2.14 of Reference (c).

7.1 Interfaces. The SUT uses the interfaces shown in Table 2-1 to connect to the Global Information Grid network. This table shows the physical interfaces supported by the SUT and the associated standards.

Table 2-1. CER Interface Requirements

Interface	Critical	UCR Reference	Criteria[(See note.)]
ASLAN Interfaces			
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE 802.3i.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE802.3u.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE 802.3z or IEEE 802.3ab.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface IEEE 802.3AN-2006 (10GBaseT).
WAN Interfaces			
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE 802.3i.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE 802.3u.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface criteria for IEEE 802.3z or IEEE 802.3ab.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	Support minimum threshold CRs/FRs (1-3) and meet interface IEEE 802.3AN-2006 (10GBaseT).
DS1	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for ANSI T1.102.
DS3/T3	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for ITU-T G.703.
E1	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for ANSI T1.102.
E3	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for ANSI T1.102.
EIA-530	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for EIA-530.
OC-X	No	5.3.2.14.9	Support minimum threshold CRs/FRs (1-2) and meet interface criteria for ANSI T1.105.
Network Management Interfaces			
10Base-X	Yes	5.3.2.4.4	Support minimum threshold CRs/FRs (4) and meet interface criteria for IEEE 802.3i.
100Base-X	Yes	5.3.2.4.4	Support minimum threshold CRs/FRs (4) and meet interface criteria for IEEE 802.3u.
1000Base-X	No	5.3.2.4.4 5.3.2.14.9	Support minimum threshold CRs/FRs (4) and meet interface criteria for IEEE 802.3z.

NOTE: The CR/FR requirements are contained in Table 2-2. The CR/FR numbers represent a roll-up of UCR requirements. Enclosure 3 provides a list of more detailed requirements for CER products.

Table 2-1. CER Interface Requirements (continued)

LEGEND:

802.3ab	1000BaseT Gbps Ethernet over twisted pair at 1 Gbps (125 Mbps)	E3	European Multiplex Rate (34.368 Mbps)
802.3an	10GBASE-X Gbps Ethernet over Fiber-Optic at 10 Gbps	EIA-530	Standard For 25-Position Interface For DTE and DCE Employing Serial Binary Data Interchange
802.3i	10 Mbps Base Band over Twisted Pair	FR	Functional Requirement
802.3u	Standard for carrier sense multiple access with collision detection at 100 Mbps	G.703	Physical/Electrical Characteristics of Hierarchical Digital Interfaces at 1544, 2048, 8448, and 44736 kbit/s Hierarchical Levels
802.3z	1000BASE-X Gbps Ethernet over Fiber-Optic at 1 Gbps	Gbps	Gigabits per second
ANSI	American National Standards Institute	IEEE	Institute of Electrical and Electronics Engineers
ASLAN	Assured Services Local Area Network	ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
CER	Customer Edge Router	kbit/s	kilobits per second
CR	Capability Requirement	Mbps	Megabits per second
DCE	Data Circuit-Terminating Equipment	OC	Optical Carrier
DS1	Digital Signal Level 1 (1.544 Mbps)	T1.102	Digital Hierarchy - Electrical Interfaces
DS3	Digital Signal Level 2 (44.736 Mbps)	T1.105	Synchronous Optical Network (SONET)
DTE	Data Terminal Equipment	UCR	Unified Capabilities Requirements
E1	European Digital Multiplex Rate (2.048 Mbps)	WAN	Wide Area Network

7.2 CR and FR. CERs have required and conditional features and capabilities that are established by Section 5.3.2.14 of the UCR. The SUT does not need to provide non-critical (conditional) requirements. If they are provided, they must function according to the specified requirements. The SUT's features and capabilities and its aggregated requirements in accordance with (IAW) the UCR CER requirements are listed in Table 2-2. Detailed CR/FR requirements are provided in Table 3-1 of Enclosure 3.

Table 2-2. CER CRs and FRs

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference
Product Interface Requirements			
1	Internal Interface Requirements	Required	5.3.2.4.1
	External Physical Interfaces between Network Components	Required	5.3.2.4.2
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2.12, para 1
	DSCP	Required	5.3.3.3.2
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3
	Traffic Conditioning Requirements	Required	5.3.3.3.4
CER Requirements[2]			
2	Traffic Conditioning	Required	5.3.2.14.1
	Differentiated Services Support	Required	5.3.2.14.2
	Per Hop Behavior Support	Required	5.3.2.14.3
	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5
	Availability	Required	5.3.2.14.7
	Packet Transit Time	Required	5.3.2.14.8
	CER Interfaces and Throughput Support	Required	5.3.2.14.9
	Assured VVoIP Latency	Required	5.3.3.4.1
	Assured VVoIP CE Latency	Required	5.3.3.4.3
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.5
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3
	Assured VVoIP CE Jitter	Required	5.3.3.5.4
	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3

Table 2-2. CER CRs and FRs (continued)

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference
CER Requirements[2] (continued)			
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4
	End-to-End Availability	Required	5.3.3.12.1
	Availability Design Factors	Required	5.3.3.12.2
	Product Quality Factors	Required	5.3.3.12.3
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2
	Provisioning	Required	5.3.3.13
	IP Routing Protocols	Required	5.3.3.14
	Voice Grade of Service	Required	5.3.3.15
	Survivability	Required	5.3.3.16[3]
IPv6 Requirements			
3	IPv6	Required	5.3.3.10
	Product Requirements	Required	5.3.5.4
NM Requirements			
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4
	NM Requirements for CERs	Required	5.3.2.18.1
	NM	Required	5.3.2.14.6

NOTES:

1. The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3.
2. If a CER meets the High Availability CER requirements, it meets all of the lesser requirements for Medium Availability with and without SQF and Low Availability. The SUT meets the High Availability and Medium Availability CER requirement with SQF in a dual chassis configuration. The Medium Availability without SQF and Low Availability are met with a single chassis configuration.
3. This is an E2E engineering requirement and, due to variations in network architectures, it cannot be accurately tested in a lab environment. To meet E2E requirements, the SUT must be deployed in accordance with its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

LEGEND:

BGP	Border Gateway Protocol	IS-IS	Intermediate System-Intermediate System
CE	Customer Edge	LoC	Letters of Compliance
CER	Customer Edge Router	LSC	Local Session Controller
CR	Capability Requirement	MFSS	Multifunction Softswitch
DSCP	Differentiated Services Code Point	NM	Network Management
E2E	End-to-End	NMS	Network Management System
EBC	Edge Boundary Controller	OSPF	Open Shortest Path First
FR	Functional Requirement	SQF	System Quality Factors
ID	Identification	SUT	System Under Test
IEEE	Institute of Electrical and Electronics Engineers	UCR	Unified Capabilities Requirements
IP	Internet Protocol	VVoIP	Voice and Video over Internet Protocol
IPv6	Internet Protocol version 6		

7.3 Information Assurance (IA). Table 2-3 details the IA requirements applicable to the CER products.

Table 2-3. CER IA Requirements

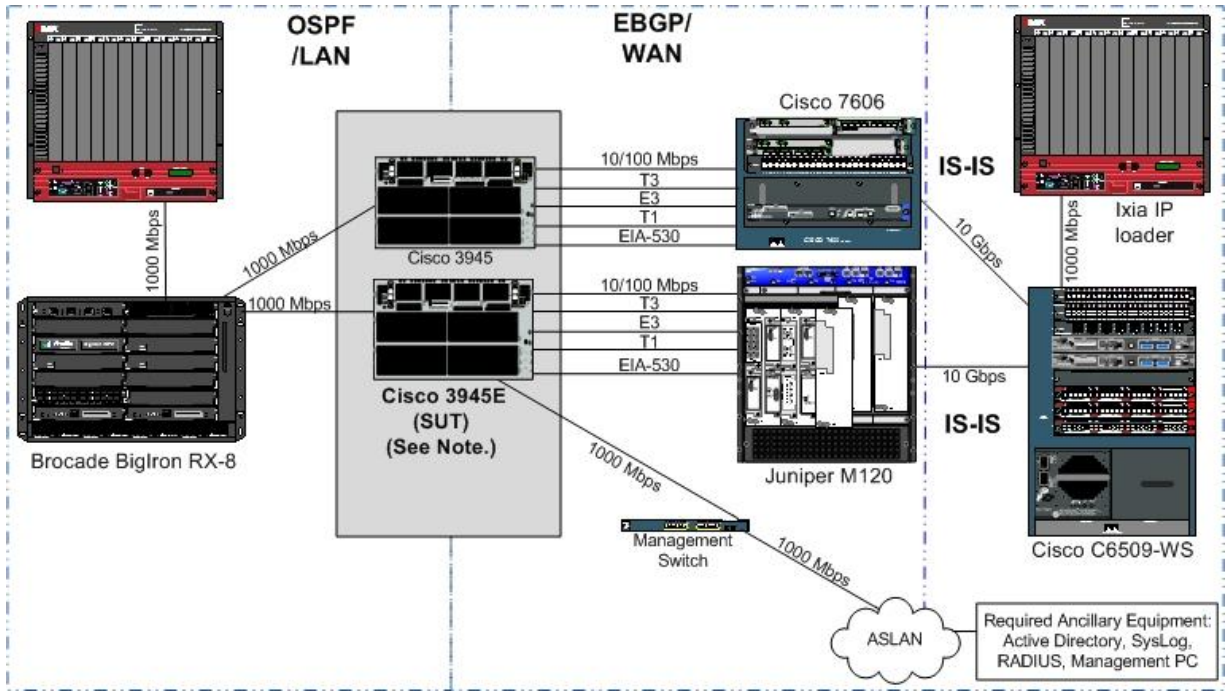
Requirement	Applicability (See note)	UCR Reference	Criteria
General Requirements	Required	5.4.6.2	Detailed requirements and associated criteria for CER are listed in Reference (e).
Authentication	Required	5.4.6.2.1	
Integrity	Required	5.4.6.2.2	
Confidentiality	Required	5.4.6.2.3	
Non-Repudiation	Required	5.4.6.2.4	
Availability	Required	5.4.6.2.5	

NOTE: The annotation of 'required' refers to a high-level requirement category of IA requirements from the UCR 2008, Change 3, Section 5.4. The detailed IA requirements are included in Reference (e).

LEGEND:
CER Customer Edge Router
IA Information Assurance
UCR Unified Capabilities Requirements

7.4 Other. None

8. TEST NETWORK DESCRIPTION. The SUT was tested at the JITC, Fort Huachuca, Arizona in a manner and configuration similar to that of a notional operational environment. Testing the system's required functions and features was conducted using the test configuration depicted in Figure 2-2. The SUT was tested in a High Availability configuration.



NOTE: The Cisco 3945E met the High Availability and Medium Availability with SQF in a dual-chassis configuration.

LEGEND:

EBGP	Edge Border Gateway Protocol	IS-IS	Intermediate System to Intermediate System
DCE	Data Circuit-Terminating Equipment	Gbps	Gigabits per second
DS1	Digital Signal Level 1 (1.544 Mbps)	LAN	Local Area Network
DS3	Digital Signal Level 3	Mbps	Megabits per second
DTE	Data Terminal Equipment	OSPF	Open Shortest Path First
EIA	Electronic Industries Alliance	PC	Personal Computer
EIA-530	Standard for 25-position interface for DTE and DCE employing serial binary data interchange	RADIUS	Remote Authentication Dial In User Service
		SQF	System Quality Factors
E3	European 3	SUT	System Under Test
Gbps	Gigabits per second	T3	Digital Transmission Link 3
IP	Internet Protocol	WAN	Wide Area Network

Figure 2-2. SUT Test Configuration

9. SYSTEM CONFIGURATIONS. Table 2-4 provides the system configurations and hardware and software components tested with the SUT. The SUT was tested in an operationally realistic environment to determine its interoperability capability with associated network devices and network traffic.

Table 2-4. Tested System Configurations

System Name		Software
Cisco C6509-WS		12.2(33)SXJ1 Release fc2
Cisco 7606		15.2(1)S Release fc1
Cisco 3945		IOS 15.1(4)M3
Brocade BigIron RX-8		2.7.2a.T145
Juniper Networks M120		Junos™ 10.0r4.7
Cisco Management Switch		12.2(53) SE2
		Equipment
Required Ancillary Equipment		Active Directory
		SysLog
		RADIUS
		Site-Provided management PC
System Under Test[1]	**Part Number**[1]	**Description**
3945E[2] 3925E IOS 15.1(4)M3	**C3900-SP150/K9**	Cisco Services Performance Engine 150 for Cisco 3945 ISR
	C3900-SP100/K9	Cisco Services Performance Engine 100 for Cisco 3925
	VWIC3-4MFT-T1/E1	4-Port T1/E1 Multiflex Trunk Voice/WAN Interface Card
	VWIC3-2MFT-T1/E1	2-Port T1/E1 Multiflex Trunk Voice/WAN Interface Card
	VWIC3-2MFT-G703	1-Port G.703 Multiflex Trunk Voice/WAN Interface Card
	VWIC3-1MFT-T1/E1	1-Port T1/E1 Multiflex Trunk Voice/WAN Interface Card
	VWIC3-1MFT-G703	1-Port G.703 Multiflex Trunk Voice/WAN Interface Card
	NM-HD-2VE	Two-slot IP Communications Enhanced Voice/Fax Network Module
	VWIC2-2MFT-T1/E1	2-Port T1/E1 Multiflex Trunk Voice/WAN Interface Card
	VWIC2-1MFT-T1/E1	1-Port T1/E1 Multiflex Trunk Voice/WAN Interface Card
	VWIC2-2MFT-G703	2-Port G.703 Multiflex Trunk Voice/WAN Interface Card
	VWIC2-1MFT-G703	1-Port G.703 Multiflex Trunk Voice/WAN Interface Card
	HWIC-1DSU-T1	1-Port CSU/DSU T1
	HWIC-4T1/E1	4 port clear channel T1/E1 HWIC
	HWIC-2FE	Two 10/100 routed port HWIC
	HWIC-1FE	One 10/100 routed port HWIC
	HWIC-4T	4-Port Serial HWIC
	HWIC-2T	2-Port Serial HWIC
	HWIC-1T	1-Port Serial HWIC
	NM-1T3/E3	One port T3/E3 network module
	NM-8CE1T1-PRI	8 port channelized T1/E1 and PRI network module
	HWIC-2CE1T1-PRI	2 port channelized T1/E1 and PRI HWIC (data only)
	HWIC-1CE1T1-PRI	1 port channelized T1/E1 and PRI HWIC (data only)
	SM-ES3G-24-P	Enhanced EtherSwitch SM, Layer 2/3 switching, 24 ports GE, POE capable
	SM-ES3-24-P	Enhanced EtherSwitch SM, Layer 2/3 switching, 23 ports FE, 1 port GE, POE capable
	SM-ES2-24-P	Enhanced EtherSwitch SM, Layer 2 switching, 23 ports FE, 1 port GE, POE capable
	SM-ES2-24	Enhanced EtherSwitch SM, Layer 2 switching, 23 ports FE, 1 port GE
	SM-ES3G-16-P	Enhanced EtherSwitch SM, Layer 2/3 switching, 16 ports GE, POE capable
	SM-ES3-16-P	Enhanced EtherSwitch SM, Layer 2/3 switching, 15 ports FE, 1 port GE, POE capable
	SM-ES2-16-P	Enhanced EtherSwitch SM, Layer 2 switching, 15 ports FE, 1 port GE, POE capable
	SM-NM-ADPTR	Network Module Adapter for SM Slot on Cisco 2900, 3900 ISR

NOTES:
1. Components bolded and underlined were tested by JITC. The other components in the family series were not tested; however, they utilize the same software and similar hardware and JITC analysis determined them to be functionally identical for interoperability certification purposes and they are also certified for joint use.
2. The high availability and medium availability with SQF solutions include the SUT in a dual-chassis configuration. The medium availability without SQF and low availability solutions do not require redundancy.

Table 2-4. Tested System Configurations (continued)

LEGEND:

E1	European Basic Multiplex Rate (2.048 Mbps)	PC	Personal Computer
FE	Fast Ethernet	POE	Power-Over-Ethernet
GE	Gigabit Ethernet	RADIUS	Remote Authentication Dial In User Service
HWIC	High-Performance Wan Interface Card	SQF	System Quality Factors
IP	Internet Protocol	SUT	System Under Test
ISR	Integrated Services Router	T1	Digital Transmission Link Level 1 (1.544 Mbps)
JITC	Joint Interoperability Test Command	VWIC	Voice/Wide Area Network Interface Card
Mbps	Megabits per second	WAN	Wide Area Network
MFT	Multiflex Trunk		

10. TESTING LIMITATIONS. None.

11. INTEROPERABILITY EVALUATION RESULTS. The SUT meets the critical interoperability requirements for a CER in accordance with UCR 2008, Change 3, section 5.3.2.14, and is certified for joint use with other network infrastructure products listed on the Unified Capabilities (UC) Approved Products List (APL). Additional discussion regarding specific testing results is located in subsequent paragraphs.

11.1 Interfaces. The interface status of the SUT is provided in Table 2-5.

Table 2-5. SUT Interface Interoperability Status

Interface	Critical	UCR Reference	Threshold CR/FR (See note.)	Status	Remarks
ASLAN Interfaces					
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000BaseT) interface.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
WAN Interfaces					
10Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.2 5.3.2.14.9	1-3	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
10GBase-X	No	5.3.2.4.2 5.3.2.14.9	1-3	Not Tested	This interface is not supported and is not required.
DS1	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
DS3	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
E1	No	5.3.2.14.9	1-2	Not Tested	This interface is supported; however, it was not tested and is not required.
E3	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
EIA-530	No	5.3.2.14.9	1-2	Certified	The SUT met all critical CRs and FRs for this interface.
OC-X	No	5.3.2.14.9	1-2	Not Tested	This interface is not supported and is not required.

Table 2-5. SUT Interface Interoperability Status (continued)

Interface	Critical	UCR Reference	Threshold CR/FR (See note.)	Status	Remarks
Network Management Interfaces					
10Base-X	Yes	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3i (10BaseT) interface.
100Base-X	Yes	5.3.2.4.4	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3u (100BaseT) interface.
1000Base-X	No	5.3.2.4.4 5.3.2.14.9	4	Certified	The SUT met all critical CRs and FRs for the IEEE 802.3ab (1000BaseT) interface.

NOTE: The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3. The system under test does not need to provide conditional requirements. However, if a capability is provided, it must function according to the specified requirements.

LEGEND:

802.3ab	1000BaseT Gbps Ethernet over twisted pair at 1 Gbps (125 Mbps)	EIA	Electronic Industries Alliance
802.3i	10BaseT Mbps over twisted pair	EIA-530	Standard for 25-position interface for DTE and DCE employing serial binary data interchange
802.3u	Standard For Carrier Sense Multiple Access With Collision Detection At 100 Mbps	FR	Functional Requirement
ASLAN	Assured Services Local Area Network	Gbps	Gigabits per second
CR	Capability Requirement	IEEE	Institute of Electrical and Electronics Engineers
DCE	Data Circuit-Terminating Equipment	LoC	Letter of Compliance
DS1	Digital Signal Level 1 (1.544 Mbps)	Mbps	Megabits per second
DS3	Digital Signal Level 3	OC	Optical Carrier
DTE	Data Terminal Equipment	SUT	System Under Test
E1	European Digital Multiplex Rate (2.048 Mbps)	UCR	Unified Capabilities Requirements
		WAN	Wide Area Network

11.2 CR and FR. The SUT CR and FR status is depicted in Table 2-6. Detailed CR/FR requirements are provided in Enclosure 3, Table 3-1.

Table 2-6. SUT CR and FR Status

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
Product Interface Requirements					
1	Internal Interface Requirements	Required	5.3.2.4.1	Met	The SUT met all critical CRs and FRs.
	External Physical Interfaces between Network Components	Required	5.3.2.4.2	Met	The SUT met all critical CRs and FRs.
	IP Queue Control Capabilities	Required	5.3.2.17.3.4.2.12 para 1	Met	The SUT met all critical CRs and FRs.
	DSCP	Required	5.3.3.3.2	Met	The SUT met all critical CRs and FRs.
	VVoIP Per-Hop Behavior Requirements	Required	5.3.3.3.3	Met	The SUT met all critical CRs and FRs.
	Traffic Conditioning Requirements	Required	5.3.3.3.4	Met	The SUT met all critical CRs and FRs.
CER Requirements					
2	Traffic Conditioning	Required	5.3.2.14.1	Met	The SUT met all critical CRs and FRs.
	Differentiated Services Support	Required	5.3.2.14.2	Met	The SUT met all critical CRs and FRs.
	Per Hop Behavior Support	Required	5.3.2.14.3	Met	The SUT met all critical CRs and FRs.

Table 2-6. SUT CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
CER Requirements (continued)					
2	Interface to the LSC/MFSS for Traffic Conditioning	Conditional	5.3.2.14.4	Not Tested	The SUT does not support this feature and it is not required.
	Interface to the LSC/MFSS for Bandwidth Allocation	Conditional	5.3.2.14.5	Not Tested	The SUT does not support this feature and it is not required.
	Availability	Required	5.3.2.14.7	Met	The SUT met all critical CRs and FRs. The SUT met High Availability CER requirements.[2]
	Packet Transit Time	Required	5.3.2.14.8	Met	The SUT met all critical CRs and FRs.
	CER Interfaces and Throughput Support	Required	5.3.2.14.9	Met	The SUT met all critical CRs and FRs.
	Assured VVoIP Latency	Required	5.3.3.4.1	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Latency	Required	5.3.3.4.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Latency	Required	5.3.3.4.5	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Jitter	Required	5.3.3.5.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Jitter	Required	5.3.3.5.4	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CER-to-CER Packet Loss	Required	5.3.3.6.3	Met	The SUT met all critical CRs and FRs.[3]
	Assured VVoIP CE Packet Loss	Required	5.3.3.6.4	Met	The SUT met all critical CRs and FRs.[3]
	End-to-End Availability	Required	5.3.3.12.1	Met	The SUT met all critical CRs and FRs.[3]
	Availability Design Factors	Required	5.3.3.12.2	Met	The SUT met all critical CRs and FRs.[3]
	Product Quality Factors	Required	5.3.3.12.3	Met	The SUT met all critical CRs and FRs.[3]
	Layer 1 – Physical Layer	Required	5.3.3.12.4.1	Met	The SUT met all critical CRs and FRs.[3]
	Layer 2 – Data Link Layer	Required	5.3.3.12.4.2	Met	The SUT met all critical CRs and FRs.[3]
	Provisioning	Required	5.3.3.13	Met	The SUT met all critical CRs and FRs.[3]
	IP Routing Protocols	Required	5.3.3.14	Met	The SUT met this requirement with Static Routing, BGP-4, IS-IS, OSPFv2, OSPFv3, and VRRP.
	Voice Grade of Service	Required	5.3.3.15	Met	The SUT met all critical CRs and FRs.[3]
	Survivability	Required	5.3.3.16	Not Tested	This is an E2E engineering requirement and is not testable in a lab environment.[4]
IPv6 Requirements					
3	IPv6	Required	5.3.3.10	Met	The SUT met all critical CRs and FRs.
	Product Requirements	Required	5.3.5.4	Met	The SUT met all critical CRs and FRs with the following minor exception: The SUT does not support the following RFCs 4301 and 4303.[5]

Table 2-6. SUT CRs and FRs Status (continued)

CR/FR ID	Capability/Function	Applicability[1]	UCR Reference	Status	Remarks
NM Requirements					
4	VVoIP NMS Interface Requirements	Required	5.3.2.4.4	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by the vendor's LoC.
	NM Requirements for CERs	Required	5.3.2.18.1	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by the vendor's LoC.
	NM	Required	5.3.2.14.6	Met	The SUT met all critical CRs and FRs for the 10/100/1000BaseT interfaces. This was met by testing and the vendor's LoC.

NOTES:
1. The annotation of 'required' refers to a high-level requirement category. The applicability of each sub-requirement is provided in Enclosure 3.
2. If a CER meets the High Availability CER requirements, it meets all of the lesser requirements for Medium Availability with and without SQF and Low Availability. The Cisco 3945 meets the High Availability with a dual-chassis configuration. The Cisco 3925 CER was not tested; however, it employs the same software and similar hardware as the Cisco 3945. JITC analysis determined this system to be functionally identical to the 3945 for interoperability certification purposes and therefore, is also certified for joint use.
3. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.
4. This is a non-testable E2E engineering requirement which states that no more than 15 percent of the B/P/C/Ss shall be affected by any outage in the network. This includes issues such as overtaxing of processing capacity, link failure, and redundancy failover glitches. However, all of the E2E voice, video, and data services performance requirements were met by the SUT when included within network structure.
5. The vendor submitted an IPv6 LoC with the following noted discrepancy: The SUT does not support RFCs 4301 and 4303. DISA adjudicated this deficiency as minor because this RFC addresses requirements for IPSec, which is an optional requirement and is not implemented in the fielded configuration.

LEGEND:

BGP	Border Gateway Protocol	LoC	Letters of Compliance
B/P/C/S	Base/Post/Camp/Station	LSC	Local Session Controller
CE	Customer Edge	MFSS	Multifunction Softswitch
CER	Customer Edge Router	NM	Network Management
CR	Capability Requirement	NMS	Network Management System
DSCP	Differentiated Services Code Point	POA&M	Plan of Actions and Milestones
E2E	End-to-End	RFC	Request for Comments
FR	Functional Requirement	OSPF	Open Shortest Path First
IAW	in accordance with	SQF	System Quality Factors
ID	Identification	SUT	System Under Test
IP	Internet Protocol	UCR	Unified Capabilities Requirements
IPv6	Internet Protocol version 6	VRRP	Virtual Router Redundancy Protocol
IS-IS	Intermediate System-Intermediate System	VVoIP	Voice and Video over Internet Protocol
JITC	Joint Interoperability Test Command		

a. Product Interface Requirements

(1) Internal Interface. The UCR 2008, Change 3, section 5.3.2.4.1, states that the CER whenever the physical interfaces use Institute of Electrical and Electronics Engineers (IEEE) 802.3 standards, they shall support auto-negotiation even when the IEEE 802.3 standard has it as optional. This applies to 10/100/1000-T Ethernet standards; i.e., IEEE, Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995; and IEEE, Gigabit Ethernet Standard 802.3ab, 1999. The SUT met the

requirements for the 10/100/1000BaseT interfaces through both testing and the vendor's Letters of Compliance (LoC).

(2) External Physical Interfaces between Network Components. The UCR 2008, Change 3, section 5.3.2.4.2, states the physical interface between an Local Session Controller (LSC) (and its appliances), the Edge Boundary Controller (EBC), the Assured Services Local Area Network (ASLAN) switches/routers, and the CER shall be a 10/100/1000-T Megabits per second (Mbps) Ethernet interface. Whenever the physical interfaces use 802.3 Ethernet standards, they shall support auto-negotiation even when the IEEE 802.3 standard has it as optional. This requirement applies to 10/100/1000-T Ethernet standards; i.e., IEEE, Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995; and IEEE, Gigabit Ethernet Standard 802.3ab, 1999. The SUT met the requirements for the 10/100/1000BaseT interfaces through both testing and the vendor's LoC.

(3) IP Queue Control Capabilities. The UCR 2008, Change 3, section 5.3.2.17.3.4.2.12, paragraph 1, states that setting the queue bandwidth allocations on the CER and its connected port on the Aggregation Router (AR) involves setting the amount (or percentage) of bandwidth allocated to each of the (currently) four queues on the CER and connected Provider Edge Router. Two bandwidth allocation actions/functions can be performed as follows: Setting the bandwidth allocations by router queue, and setting the drop probabilities with each queue if the router supports this functionality. The SUT met this requirement with both testing and the vendor's LoC.

(4) Differentiated Services Code Point (DSCP). The UCR 2008, Change 3, section 5.3.3.3.2, states that the product shall support the DSCP plan as shown in Table 5.3.3-1. DiffServ assignments shall be software configurable for the full range of six bit values (0-63 Base10) for backwards compatibility with IP precedence environments that may be configured to use the Type of Service (TOS) field in the IP header but do not support DSCP. The SUT met these requirements through testing and the vendor's LoC.

(5) Video and Voice over Internet Protocol (VVoIP) Per-Hop Behavior (PHB). The UCR 2008, Change 3, section 5.3.3.3.3, states the following:

(a) The system routers supporting VVoIP shall support and configure the four-queue PHBs, as defined in Table 5.3.3-2, Four-Queue PHB Approach. The SUT met these requirements through testing and the vendor's LoC.

(b) The system routers supporting VVoIP shall support and configure the six-queue PHBs as defined in Table 5.3.3-3, Six-Queue PHB Approach. The SUT met these requirements through testing and the vendor's LoC.

(6) Traffic Conditioning. The UCR 2008, Change 3, section 5.3.3.3.4, includes the requirements in the sub-paragraphs below.

(a) All CER and/or AR interfaces in the direction of the CER shall support traffic conditioning on an aggregate granular service class basis on the input interface. The SUT met this requirement with both testing and the vendor's LoC.

(b) The CER shall be able to traffic condition using IP addresses, Virtual Local Area Network (VLAN) tags, protocol port numbers, and DSCPs as discriminators, as a minimum. The SUT met granular service class basis for 10/100BaseT, European (E)3, Digital Signal Level (DS) 3, DS1, and serial Electronic Industries Alliance (EIA)-530 WAN interfaces within +/- 10 percent of the shaped queue for all WAN interfaces. The SUT met this requirement with both testing and the vendor's LoC.

(c) All CER and/or AR interfaces toward the CER shall support traffic conditioning on a granular service class basis on the output interface. The SUT met granular service class basis within +/- 10 percent of the shaped queue for 10/100BaseT, E3, DS3, DS1, and serial EIA-530 interfaces. The SUT met this requirement with both testing and the vendor's LoC.

b. CER Requirements

(1) Traffic Conditioning. The UCR 2008, Change 3, section 5.3.2.14.1, states that the product shall be capable of performing traffic conditioning (policing and shaping) on inbound and outbound traffic. Traffic conditioning may involve the dropping of excess packets or the delaying of traffic to ensure conformance with Service Level Agreements (SLAs). The product shall be capable of traffic conditioning the bandwidth associated with a service class. The SUT met the requirement for performing traffic conditioning for inbound and outbound traffic, which was verified through testing. The SUT also met the traffic conditioning of bandwidth with a service class for both IPv4 and IPv6 with testing and the vendor's LoC.

(2) Differentiated Services (DiffServ) Support. The UCR 2008, Change 3, section 5.3.2.14.2, states that the SUT shall be capable of supporting DiffServ IAW request for comments (RFCs) 2475 and 2474. The SUT met this requirement for both IPv4 and IPv6 with both testing and the vendor's LoC.

(3) Per-Hop Behavior (PHB) Support. The UCR 2008, Change 3, section 5.3.2.14.3, states that the SUT shall be capable of supporting the PHBs as specified in section 5.3.3. The SUT shall be capable of supporting Expedited Forwarding PHBs IAW RFC 3246 and Assured Forwarding PHB IAW RFC 2597. The SUT met these requirements with both testing and the vendor's LoC.

(4) Interface to the LSC/Multifunction Softswitch (MFSS) for Traffic Conditioning. The UCR 2008, Change 3, section 5.3.2.14.4, states that the SUT shall be capable of interfacing to the LSC or MFSS in real time to adjust traffic conditioning parameters based on the updated LSC/MFSS budget. This conditional requirement is not supported by the SUT.

(5) Interface to the LSC/MFSS for Bandwidth Allocation. The UCR 2008, Change 3, section 5.3.2.14.5, states that the SUT shall be capable of interfacing to the LSC/MFSS in real time to adjust the PHB bandwidth allocations based on the updated LSC/MFSS budgets. This conditional requirement is not supported by the SUT.

(6) Availability. The UCR 2008, Change 3, section 5.3.2.14.7, depicts the four types of CERs and their associated availability requirements. Locations serving FLASH OVERRIDE/FLASH users and IMMEDIATE/PRIORITY users and ROUTINE users with PRIORITY and above precedence should install High Availability CERs. The Medium Availability and Low Availability CERS provide cost-effective solutions for locations that serve ROUTINE users. The SUT met the requirements for High Availability CER with the vendor's LoC. A system that meets High Availability requirements meets the lesser availability categories of CER. The SUT is certified with any equivalent Layer 3 ASLAN component listed on the UC APL.

(a) The High Availability CER shall have an availability of 99.999 percent, including scheduled hardware and software maintenance (non-availability of no more than five minutes per year). The High Availability CER shall meet the requirements specified in UCR 2008, Change 3, section 5.3.2.5.2, Product Quality Factors. The Cisco 3945E met this requirement with a dual chassis. This requirement was met by the vendor's LoC.

(b) The Medium Availability CER with SQF shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The Medium Availability CER with SQF shall meet the requirements specified in UCR 2008, Change 3, section 5.3.2.5.2, Product Quality Factors. The Cisco 3945E met this requirement with a dual chassis. This requirement was met by the vendor's LoC.

(c) The Medium Availability CER without SQF shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). This requirement was met by the vendor's LoC.

(d) The Low Availability CER shall have an availability of 99.9 percent, including scheduled hardware and software maintenance (non-availability of no more than 8.76 hours per year). This requirement was met by the vendor's LoC.

(7) Packet Transit Time. The UCR 2008, Change 3, section 5.3.2.14.8, states that the SUT shall be capable of receiving, processing, and transmitting a voice packet within 2 milliseconds (ms) or less in addition to the serialization delay for voice packets as measured from the input interface to output interface under congested conditions (as described in UCR 2008 Change 3, section 5.3.1.4.1.1, ASLAN Voice Services Latency) to include all internal functions. Each of these interfaces met the requirement for latency in accordance with the UCR. The SUT measured latencies are shown in Table 2-7.

Table 2-7. SUT Measured Latency

Interface	Measured	UCR Requirement
	Cisco 7609-S	
100BaseT	.43 ms	2 ms
10BaseT	1.3 ms	2 ms
E3	.978	15 ms or less
DS3	.759 ms	15 ms or less
T1	9.0 ms	15 ms or less
Serial EIA-530 8.064Mb	2.0 ms	15 ms or less
Serial EIA-530 2.048Mb	7.6 ms	15 ms or less

LEGEND:

DS3	Digital Signal Level 3	Mbps	Megabits per second
E3	European 3	ms	millisecond
EIA	Electronic Industries Alliance	OC	Optical Carrier
EIA-530	Standard for 25-position interface for data terminal equipment (DTE) and data circuit-terminating equipment (DCE) employing serial binary data interchange	POS	Pacet Over SONET
		SUT	System Under Test
		T1	Digital Transmission Link Level 1 (1.544 Mbps)
		UCR	Unified Capabilities Requirements

(8) CER Interfaces and Throughput Support. The UCR 2008, Change 3, section 5.3.2.14.9, states that the CER supports an Assured Services Local Area network (ASLAN)-side connection to the EBC and a WAN-side connection to the DISN WAN. The ASLAN-side interface shall be an Ethernet interface (10Base-T or 100Base-T) full duplex. At least one of the WAN-side interfaces shall be an Ethernet interface (10Base-T or 100Base-T) full duplex. The SUT met the requirement through testing and the vendor's LoC.

(a) The CER may conditionally support a WAN-side access connection interface which can also be Time Division Multiplexing (TDM)-based (i.e., DS1, DS3, or European Basic Multiplex Rate [E1]). These are all full-duplex interfaces, and support two-way simultaneous information exchange at the "line rate" for the interface (i.e., 1.5 Mbps for DS1, 45 Mbps for DS3, 34 Mbps for E3, 2.0 Mbps for E1). The SUT is certified for the following WAN interfaces: Ethernet 10BaseT, Ethernet 100BaseT, E3, DS3, Digital Transmission Link Level 1 (T1), and serial EIA-530.

(b) The CER may conditionally support a WAN-side access connection interface which can also be SONET based (i.e., Optical Carrier [OC]-3, OC-12, OC-48, or OC-192). These are all full-duplex interfaces, and support two-way simultaneous information exchange at the "line rate" for the interface. The SUT does not support SONET based interfaced. This is a conditional requirement.

(c) The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the ASLAN-to-WAN direction. The SUT met the requirement through testing and the vendor's LoC. The IEEE Gigabit Ethernet Standard 802.3u (100BaseT) interface had a measured throughput of 99.9 percent.

(d) The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the WAN-to-ASLAN

direction. The maximum possible throughput on the WAN side interface shall be the maximum line rate that the WAN-side interface is provisioned for on the CER. Each of these interfaces met the requirement for throughput in accordance with the UCR. The SUT measured throughputs are shown in Table 2-8.

Table 2-8. SUT Measured Throughput

Interface	Maximum Possible Throughput	SUT Throughput		Remarks
		Percentage	Measurement	
100BaseT	100 Mbps	99.0%	99 Mbps	See Note
10BaseT	10 Mbps	99.0%	9 Mbps	See Note
E3	34 Mbps	99.0%	33.6 Mbps	See Note
DS3	45 Mbps	99.2%	44.64	See Note
T1	1.5 Mbps	99.2%	1.524 Mbps	See Note
Serial EIA-530 8.064Mb	8.064 Mbps	99.2%	7.99 Mbps	See Note
Serial EIA-530 2.048Mb	2.048 Mbps	99.2%	2.031 Mbps	See Note

NOTE: Measured Throughput was met based on calculations, allows for overhead and traffic packet size.

LEGEND:

ATM	Asynchronous Transfer Mode	OC	Optical Carrier
DS3	Digital Signal Level 3 (44.736 Mbps)	OC-3	Optical Carrier Level 3 (155 Mbps)
E3	European Multiplex Rate (34.368 Mbps)	OC-12	Optical Carrier Level 12 (622 Mbps)
EIA	Electronic Industries Alliance	OC-48	Optical Carrier Level 48 (2.448 Gbps)
EIA-530	Standard for 25-position interface for data terminal equipment (DTE) and data circuit-terminating equipment (DCE) employing serial binary data interchange	POS	Packet Over SONET
		SONET	Synchronous Optical Network
		SUT	System Under Test
		T1	Digital Transmission Link Level 1 (1.544 Mbps)
Mbps	Megabits per second	UCR	Unified Capabilities Requirements
ms	millisecond		

(9) Assured VVoIP Customer Edge (CE) latency. The UCR 2008, Change 3, section 5.3.3.4, states that the DISN Network infrastructure products supporting VVoIP shall meet the latency requirements in the subparagraphs below. The requirements in the sub-paragraphs below depict End-to-End (E2E) engineering requirements. To meet E2E CER requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(a) Assured VVoIP Latency. The UCR 2008, Change 3, section 5.3.3.4.1, states that all CERs shall be capable of receiving, processing, and transmitting a voice packet within 2 ms or less in addition to the serialization delay for voice packets as measured from the input interface to output interface under congested conditions. The SUT met all the critical UCR interoperability capability and feature requirements for CER. The JITC measured the individual product latency for the following WAN interfaces: 0.43 ms for 10/100 Ethernet, 1.0 ms for E3, 759 ms for DS3, 9.0 ms for DS1, and 2.0 ms for EIA-530, which met the individual product latency requirement. Therefore, the following E2E CER requirements were also met in an emulated operational environment. To meet E2E CER requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(b) The UCR 2008, Change 3, section 5.3.3.4.3, states that the CE Segment supporting VVoIP shall ensure that the one-way latency from the IP handset to

the egress interface of the CER within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions as averaged over any 5-minute period. The SUT met the individual product requirement for latency in an emulated E2E environment.

(c) The UCR 2008, Change 3, section 5.3.3.4.3, states that the CE Segment supporting VVoIP shall ensure that the one-way latency from the CER to the IP handset within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions as averaged over any 5-minute period. The SUT met the individual product requirement for latency in an emulated E2E environment.

(d) Assured VVoIP CER to CER Latency. The UCR 2008, Change 3, section 5.3.3.4.5, states that the DISN Network Infrastructure supporting VVoIP shall ensure that the one-way latency from the CER to the CER across the DISN Network Infrastructure for Fixed to Fixed (F-F) nodes does not exceed 150 ms (or 132 ms if the CER is collocated with an AR) for VVoIP as averaged over any 5-minute period. The SUT met the individual product requirement for latency in an emulated E2E environment. The SUT measured latencies are shown in Table 2-7.

(10) Assured VVoIP Jitter. The UCR 2008, Change 3, section 5.3.3.5, states that the DISN Network infrastructure products supporting VVoIP shall meet the jitter requirements in the subparagraphs below. The requirements in the sub-paragraphs below depict E2E engineering requirements. To meet E2E CER requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(a) Assured VVoIP CER-to-CER Jitter. The UCR 2008, Change 3, section 5.3.3.5.3, states that the CE Segment supporting VVoIP shall ensure that the one-way jitter from the CER to the CER across the DISN Network Infrastructure for F-F does not exceed 14 ms (or 10 ms if the CER is collocated with the AR) for VVoIP sessions during any 5-minute period. The SUT met this requirement in an emulated operational network with a measured E2E jitter of 0.092 ms for Ethernet,.296 for E3, .183 ms for DS3, 5.49 ms for T1, 1.17 for serial EIA-530 at 2048 ms and 4.5 ms for serial EIA-530 at 8 ms.

(b) Assured VVoIP CE Jitter. The UCR 2008, Change 3, section 5.3.3.5.4, states that the CE Segment supporting VVoIP shall ensure that the one-way jitter between the handset and CER within the Edge Segment does not exceed 3 ms (or 5 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period. The SUT met the E2E requirement for jitter for Ethernet and DS3 WAN interfaces.

(11) Assured VVoIP Packet Loss. The UCR 2008, Change 3, section 5.3.3.6, states that the DISN Network infrastructure products supporting VVoIP shall meet the packet loss requirements in the subparagraphs below. The requirements in the sub-

paragraphs below depict E2E engineering requirements. To meet E2E CER requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(a) The UCR 2008, Change 3, section 5.3.3.6.3, states that the DISN Network Infrastructure supporting VVoIP shall ensure that the one-way packet loss from the CER across the DISN Network Infrastructure for F-F nodes does not exceed 0.8 percent (or 0.3 percent if the CERs are collocated with the ARs) for VVoIP sessions as averaged over any 5-minute period. The SUT met this requirement in an emulated operational network with a measured E2E packet loss of 0 percent for all interface types.

(b) The UCR 2008, Change 3, section 5.3.3.6.4, states that the CE Segment supporting VVoIP shall ensure that the one-way packet loss between the handset and CER does not exceed 0.05 percent for VVoIP sessions as averaged over any 5-minute period. The SUT met this requirement in an emulated operational network with a measured E2E packet loss of 0 percent for all interface types.

(12) System-Level Quality Factors. The UCR 2008, Change 3, section 5.3.3.12, System-Level Quality Factors are in the sub-paragraphs below.

(a) The UCR 2008, Change 3, section 5.3.3.12.1, states that all CERs shall meet the SQFs E2E Availability in the sub-paragraphs below. The requirements in the sub-paragraphs below depict E2E engineering requirements. To meet the E2E requirements the SUT must be deployed IAW its deployment guide and per engineering guidelines provided in UCR 2008, Change 3, section 5.3.3. The below availability requirements were met by the SUT with the vendor's LoC.

1. The availability for the network infrastructure within the F-F from CER to CER shall be 99.96 percent or greater to include scheduled maintenance.

2. The availability to include scheduled maintenance for the network infrastructure within a CE Segment, which includes ASLAN and EBC shall be 99.998 percent or greater for FO/F users, 99.996 percent or greater for I/P users, and 99.8 percent or greater for other users.

(b) Availability Design Factors. The UCR 2008, Change 3, section 5.3.3.12.2, states that the CER, as part of E2E network infrastructure, shall meet the following Availability Design Factors:

1. The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall have no single point of failure to include power sources and NM. The SUT met this requirement through testing and the vendor's LoC.

2. In the event of an E2E network infrastructure component failure in a network supporting VVoIP users with precedence about ROUTINE, all sessions that

are active shall not be disrupted (i.e., loss of existing connection requiring redialing) and a path through the network shall be restored with 5 seconds. The SUT met this requirement through testing and the vendor's LoC. The SUTs restoral time was between .342 and 4.5 seconds. These figures include IPv4 and IPV6 traffic transmitting Voice, Data and Best Effort packets. The restoral times are representative of BGP, OSPF and Chassis failover data.

3. No segment of the E2E network infrastructure shall use split cost metric routing for VVoIP traffic. The SUT met this requirement through testing and the vendor's LoC.

4. All network infrastructure products supporting VVoIP users with precedence above ROUTINE shall have eight hours of backup power. Backup power is provided by the B/P/C/S site where the SUT is deployed. The SUT has redundant power supplies to prevent single point of failure and works with backup power. However, backup power is not part of the SUT. This requirement is not a SUT requirement.

(13) Product Quality Factors. The UCR 2008, Change 3, section 5.3.3.12.3, states that the CER, as part of E2E network infrastructure, shall meet the Product Quality Factors in the sub-paragraphs below.

(a) The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall support a protocol that allows for dynamic rerouting of IP packets to eliminate any single points of failure. The SUT met this requirement with dynamic routing protocols supported including Virtual Router Redundancy Protocol, Open Shortest Path First (OSPF), OSPFv3, Intermediate System-to-Intermediate System Protocol (IS-IS), and Border Gateway Protocol (BGP) dynamic routing protocols.

(b) All network infrastructure products supporting VVoIP users with precedence above ROUTINE used to meet the reliability requirements shall be capable of handling the entire session processing load in the event that its counterpart product fails. The SUT met this requirement with redundant routing engines and switch fabrics.

(c) All network infrastructure products supporting VVoIP that implement Multiprotocol Label Switching (MPLS) shall have a Fast Re-Route capability that restores paths around a local failure (i.e., a failure involving a single router or circuit) within 50 ms. The MPLS protocol is offered by the SUT; however, it was not tested and since it is not required by the SUT it is not certified for joint use.

(d) Network infrastructure routers shall only enact switchovers based on a reduction in access network throughput or bandwidth with NM troubleshooting procedures, because the routers cannot determine where or what in the access IP connection is the cause of the reduction. This requirement was met through testing and the vendor's LoC.

(e) If the network infrastructure supports users with precedence above ROUTINE, then the network infrastructure routers shall provide an availability of 99.999 percent to include scheduled maintenance. The availability requirement of 99.999 for High Availability was met with the vendor's LoC.

(f) If the CER has at least two separate access connections (i.e., dual homed) and detects an access connection failure, the CER shall switch to the alternate or backup access connection using an automatic process and shall not require operator actions. The SUT met this requirement through testing and the vendor's LoC.

(14) Design and Construction Materials. The CER shall meet design and construction materials requirements of the UCR 2008, Change 3, section 5.3.3.12.4, listed in the sub-paragraphs below.

(a) Layer 1 – Physical Layer. The UCR 2008, Change 3, section 5.3.3.12.4.1, states that all F-F network infrastructure network connections supporting VVoIP shall have a bandwidth of T1 (1.544 Mbps) or greater. The SUT certified interfaces met this requirement through testing and the vendor's LoC.

(b) Layer 2 – Data Link Layer. The UCR 2008, Change 3, section 5.3.3.12.4.2, includes the requirements in the sub-paragraphs below.

1. The E2E network infrastructure (excluding session originators) supporting VVoIP sessions shall use the media default Maximum Transmission Unit (MTU). The media default MTU for Ethernet is 1500 bytes. The SUT met this requirement through testing and the vendor's LoC.

2. The E2E network infrastructure supporting VVoIP sessions shall permit packet fragmentation. This is an E2E requirement which can not be measured in a lab environment. IPv6 packet fragmentation is not possible with routers.

3. All E2E network infrastructure network connections consisting of Ethernet connections that support VVoIP shall be switched full-duplex connections. The SUT met this requirement through testing and the vendor's LoC.

4. All E2E network infrastructure product Ethernet interfaces shall support auto-negotiation as described in the IEEE 802.3 series of standards. The SUT met this requirement through testing and the vendor's LoC.

5. All E2E network system network links consisting of Ethernet connections that support VVoIP shall not exceed IEEE recommended distances for Ethernet cabling as shown in the UCR 2008, Change 3, Table 5.3.3-5. The links connected to the SUT were within the recommended distances during testing and met the requirement.

(15) Provisioning. The UCR 2008, Change 3, section 5.3.3.13, states that the CER shall support the provisioning requirements in the sub-paragraphs below. The SUT met all the critical UCR interoperability capability and feature requirements for CER. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(a) The E2E network Infrastructure supporting VVoIP shall assume the use of International Telecommunication Union - Telecommunication Standardization Sector (ITU-T) G.711 (20 ms) for calculating bandwidth budgets within the fixed network even if compressed codecs are used. This requirement was met by the SUT with testing.

(b) The E2E network infrastructure design shall provide, at a minimum a 25 percent increase in network capacity (i.e., throughput and number of sessions) above the current employed network capacity at all tandem switches, Multifunction Switches, MFSSs, and critical dual-homed End Office (EO) switches and LSCs. This requirement was met by the SUT with testing.

(16) IP Routing Protocols. The UCR 2008, Change 3, section 5.3.3.14, states that the CER shall support the following interchangeability requirements in the sub-paragraphs below. All Edge System routers supporting VVoIP shall support, as a minimum, the following protocols and methods.

(a) Static Routing. Static routing is a manual method for determining the path that traffic should take on egress from a router. The SUT met this requirement through testing and the vendor's LoC.

(b) BGP-4. The BGP-4 is a protocol for exchanging routing information between gateway hosts (each with its own router) in a network of autonomous systems and is described in RFCs 4271 and 1772. The SUT met this requirement through testing and the vendor's LoC.

(c) IS-IS. The IS-IS is an OSI protocol by which intermediate systems exchange routing information. This protocol is not intended to be used as the protocol to interface to the ARs. It is a second method for interfacing between the P Router and the AR and typically is associated with dual-homed Edge Segments. The SUT met IS-IS requirement through testing and the vendor's LoC.

(d) The OSPF is an interior gateway protocol used to route IP packets within a routing domain. The OSPF version 2 for IPv4 is described in RFC 2328. Updates to OSPF for IPv6 are described in RFC 5340. The SUT met OSPF v2 and v3 requirements through testing and the vendor's LoC.

(17) Voice Grade of Service (GOS). The UCR 2008, Change 3, section 5.3.3.15, states that the CER, as part of E2E network infrastructure, shall meet the

Product interchangeability requirements in the sub-paragraphs below. The requirements in the sub-paragraphs below depict E2E engineering requirements. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(a) The E2E network infrastructure shall provide a GOS of P.00 (i.e., zero sessions out of 100 will be "blocked" during the "busy hour") for FLASH and FLASH OVERRIDE voice and video (VVoIP only) sessions. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(b) The E2E network infrastructure shall provide a GOS of P.02 (i.e., two sessions out of 100 will be blocked during the busy hour) and P.01, respectively, during a 100 percent increase above normal precedence usage for PRIORITY and IMMEDIATE voice and video (VVoIP only) sessions at a minimum. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(c) The E2E network infrastructure supporting VVoIP shall provide a peacetime theater GOS of P.07 (i.e., seven voice sessions out of 100 will be blocked during the busy hour) or better, and an intertheater GOS of P.09 or better, as measured during normal business hours of the theaters for ROUTINE precedence voice and video (VVoIP only) sessions traversing the network from an EO or LSC End Instrument (EI) and/or Assured Services Session Initiation Protocol (AS-SIP) EI. This requirement was verified in an emulated operational environment. To meet E2E requirements, the SUT must be deployed IAW its deployment guide and the engineering guidelines provided in UCR 2008, Change 3, section 5.3.3.

(18) VVoIP Network Infrastructure Survivability. The UCR 2008, Change 3, section 5.3.3.16, states that no more than 15 percent of the B/P/C/Ss shall be affected by an outage in the network. This requirement is a core network requirement which can not be measured in a lab environment.

c. IPv6 Requirements. The UCR 2008, Change 2, section 5.3.3.10, states that the network infrastructure products supporting VVoIP shall accept, route, and process IPv6 protocol traffic while providing parity to IPv4. The IPv6 requirements are in the UCR 2008, Change 3, section 5.3.5. The CER met the IPv6 requirements with testing and the vendor's LoC with the following exceptions. The SUT does not support RFCs 4301 and 4303. DISA adjudicated this deficiency as minor because this RFC addresses requirements for IPSec, which is not implemented in the fielded configuration.

d. Network management (NM) Requirements for CERs

(1) Video and Voice over Internet Protocol (VVoIP) Network Management System (NMS) Interface. The UCR 2008, Change 3, section 5.3.2.4.4, states that the physical VVoIP NMS interface between the DISA VVoIP Element Management System (EMS) and the network components (i.e., LSC, MFSS, EBC, and CER) is a 10/100-Mbps Ethernet interface. The interface will work in either of the two following modes using auto-negotiation: IEEE, Ethernet Standard 802.3, 1993; or IEEE, Fast Ethernet Standard 802.3u, 1995. The SUT met the requirements for the 10/100BaseT interfaces by the vendor's LoC.

(2) The UCR 2008, Change 3, section 5.3.2.18, states that the CER shall support the network management requirements for CERs specified below:

(a) The CER shall report faults IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(b) The CER shall present configuration management (CM) IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(c) The CER shall present performance management (PM) IAW RFCs 1215 and 3418. This requirement was met by the vendor's LoC.

(d) Conditionally, nonstandard (vendor-specific) CM and PM information shall be presented as private vendor Management Information Base, as defined by the applicable RFCs. This conditional requirement was met by the vendor's LoC.

(e) The CER QoS queues must be readable and settable by the VVoIP EMS. This requirement was met by the vendor's LoC.

(3) Network Management (NM). The UCR 2008, Change 3, section 5.3.2.14.6, states that the SUT shall support fault, configuration, accounting, performance and security NM functions as defined in the UCR 2008, Change 3, section 5.3.2.17, Management of Network Appliances. This requirement was met by the vendor's LoC.

11.3 Information Assurance. Security is tested by DISA-led Information Assurance test teams and published in a separate report, Reference (e).

11.4 Other. None

12. TEST AND ANALYSIS REPORT. No detailed test report was developed in accordance with the Program Manager's request. JITC distributes interoperability information via the JITC Electronic Report Distribution (ERD) system, which uses Unclassified-But-Sensitive Internet Protocol Router Network (NIPRNet) e-mail. More comprehensive interoperability status information is available via the JITC System Tracking Program (STP). STP is accessible by .mil/gov users on the NIPRNet at https://stp.fhu.disa.mil. Test reports, lessons learned, and related testing documents

and references are on the JITC Joint Interoperability Tool (JIT) at http://jit.fhu.disa.mil (NIPRNet). Information related to DSN testing is on the Telecom Switched Services Interoperability (TSSI) website at http://jitc.fhu.disa.mil/tssi. Due to the sensitivity of the information, the Information Assurance Accreditation Package (IAAP) that contains the approved configuration and deployment guide must be requested directly through government civilian or uniformed military personnel from the Unified Capabilities Certification Office (UCCO), e-mail: disa.meade.ns.list.unified-capabilities-certification-office@mail.mil.

SYSTEM FUNCTIONAL AND CAPABILITY REQUIREMENTS

The Customer Edge Routers (CERs) have required and conditional features and capabilities that are established by Section 5.3.2.14 of the Unified Capabilities Requirements (UCR). The System Under Test (SUT) need not provide conditional requirements. If they are provided, they must function according to the specified requirements. The detailed Functional Requirements (FR) and Capability Requirements (CR) for CERs are listed in Table 3-1. Detailed Information Assurance (IA) requirements are included in Reference (e) and are not listed below.

Table 3-1. CER Capability/Functional Requirements

ID	Requirement	UCR Reference	Required (R) Conditional (C)
1	Internal Interfaces are functions that operate internal to a SUT or UC-approved product. Whenever the physical interfaces use IEEE 802.3 Ethernet standards, they shall support auto-negotiation even when the IEEE 802.3 standard states it is optional. This applies to 10/100/1000-T Ethernet standards; i.e., IEEE Ethernet Standard 802.3, 1993; IEEE Fast Ethernet Standard 802.3u, 1995; and IEEE Gigabit Ethernet Standard 802.3ab, 1999.	5.3.2.4.1	R
2	External physical interfaces between components are functions that cross the demarcation point between SUT and other external network components. The physical interface between an LSC (and its appliances), EBC, ASLAN switches/routers, and the CER shall be a 10/100/1000-T Mbps Ethernet interface. Whenever the physical interfaces use IEEE 802.3 Ethernet standards, they shall support auto-negotiation even when the IEEE 802.3 standard states it is optional. This applies to 10/100/1000-T Ethernet standards; i.e., IEEE Ethernet Standard 802.3, 1993; IEEE Fast Ethernet Standard 802.3u, 1995; and IEEE Gigabit Ethernet Standard 802.3ab, 1999.	5.3.2.4.2	R
3	The physical VVoIP NMS interface between the DISA VVoIP EMS and the network components (i.e., LSC, MFSS, EBC, CER) is a 10/100-Mbps Ethernet interface. The interface will work in either of the two following modes using auto-negotiation: IEEE Ethernet Standard 802.3, 1993 or IEEE Fast Ethernet Standard 802.3u, 1995.	5.3.2.4.4	R
4	The product shall be capable of performing traffic conditioning (policing and shaping) on inbound and outbound traffic.	5.3.2.14.1	R
5	The product shall be capable of traffic conditioning the bandwidth associated with a service class.	5.3.2.14.1	R
6	The product shall be capable of supporting DiffServ in accordance with RFCs 2475 and 2474.	5.3.2.14.2	R
7	The product shall be capable of supporting the PHBs, as specified in UCR 2008, Change 3, Section 5.3.3.	5.3.2.14.3	R
8	The product shall be capable of supporting EF PHBs in accordance with RFC 3246.	5.3.2.14.3	R
9	The product shall be capable of supporting the AF PHB in accordance with RFC 2597.	5.3.2.14.3	R
10	The CER shall be capable of interfacing to the LSC/MFSS in real time to adjust traffic conditioning parameters based on the updated LSC/MFSS budgets.	5.3.2.14.4	C
11	The product shall be capable of interfacing to the LSC/MFSS in real time to adjust the PHB bandwidth allocations based on the updated LSC/MFSS budgets.	5.3.2.14.5	C
12	The product shall support FCAPS Network Management functions as defined in the UCR 2008, Change 3, Section 5.3.2.17.	5.3.2.14.6	R
13	The product shall have an availability of 99.999 percent, including scheduled hardware and software maintenance (non-availability of no more than 5 minutes per year). The product shall meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a high availability CER.	5.3.2.14.7	R

Table 3-1. CER Capability/Functional Requirements (continued)

ID	Requirement	UCR Reference	Required (R) Conditional (C)
14	The product shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The product does not need to meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a medium availability CER without SQF.	5.3.2.14.7	R
15	The product shall have an availability of 99.99 percent, including scheduled hardware and software maintenance (non-availability of no more than 52.5 minutes per year). The product shall meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a medium availability CER with SQF.	5.3.2.14.7	C
16	The product shall have an availability of 99.9 percent, including scheduled hardware and software maintenance (non-availability of no more than 8.76 hours per year). The product does not need to meet the requirements specified in the UCR 2008, Change 3, Section 5.3.2.5.2. This applies to a low availability CER.	5.3.2.14.7	C
17	The CER shall be capable of receiving, processing, and transmitting a voice packet within 2 ms or less in addition to the serialization delay for voice packets with no variance, if both of the CE Router access interfaces (input and output) are 10BT, DS3, 100BT, or higher and within 15 ms or less, with no variance, if one of the CE Router access interfaces (input and output) is T1, E1, or lower as measured from the input interface to output interface under congested conditions.	5.3.2.14.8	R
18	The ASLAN-side interface shall be an Ethernet interface (10Base-T, 100Base-T) full duplex. At least one of the WAN-side interfaces shall be an Ethernet interface (10Base-T or 100Base-T) full duplex.	5.3.2.14.9	R
19	The WAN-side access connection interface can also be TDM based (i.e., DS1, DS3, or E1). These are all full-duplex interfaces, and support two-way simultaneous information exchange at the “line rate” for the interface (i.e., 1.5 Mbps for DS1, 45 Mbps for DS3, 2.0 Mbps for E1).	5.3.2.14.9	C
20	The WAN-side access connection interface can also be SONET based (i.e. OC3, OC12, OC48, or OC192). These are full-duplex interfaces, and support two-way simultaneous information exchange at the “line rate” for the interfaces.	5.3.2.14.9	C
21	The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the ASLAN-to-WAN direction.	5.3.2.14.9	R
22	The CER shall support the maximum possible throughput on the WAN-side interface for a full traffic load of all traffic types sent in the WAN-to-ASLAN direction.	5.3.2.14.9	R
23	The CER shall support the maximum possible throughput on the WAN side interface in a full-duplex mode, for a full traffic load of UC packets sent simultaneously in both the ASLAN-to-WAN and WAN-to-ASLAN directions.	5.3.2.14.9	R
24	The maximum possible throughput on the WAN-side interface shall be the maximum line rate that the WAN-side interface is provisioned for on the CER.	5.3.2.14.9	R
25	Setting the queue bandwidth allocations on the CER and its connected port on the AR involves setting the amount (or percentage) of bandwidth allocated to each of the (currently) four queues on the CER and connected PE Router. Two bandwidth allocation actions/functions can be performed as follows: Setting the bandwidth allocations by router queue and setting the drop probabilities with each queue if the router supports this functionality.	5.3.2.17.3.4.2 .12 para 1	R
26	Faults will be reported IAW RFCs 1215 and 3418.	5.3.2.18.1	R
27	Standard CM information shall be presented IAW RFCs 1213 and 3418.	5.3.2.18.1	R
28	Standard PM information shall be presented IAW RFCs 1213 and 3418.	5.3.2.18.1	R
29	Nonstandard (vendor-specific) CM and PM information shall be presented as private vendor MIBs, as defined by the applicable RFCs.	5.3.2.18.1	C
30	The CER QoS queues must be readable and settable by the VVoIP EMS.	5.3.2.18.1	R
31	The product shall support the plain text DSCP plan, as shown in UCR 2008, Change 3, Table 5.3.3-1, and the DSCP assignment shall be software configurable for the full range (0-63) to support Deployable deployments that may not use the following DSCP plan.	5.3.3.3.2	R

Table 3-1. CER Capability/Functional Requirements (continued)

ID	Requirement	UCR Reference	Required (R) Conditional (C)
32	The system routers supporting VVoIP shall support the four-queue PHBs as defined in the UCR 2008, Change 3, Table 5.3.3-2.	5.3.3.3.3 para 1	R
33	The system routers supporting VVoIP shall support the six-queue PHBs as defined in the UCR 2008, Change 3, Table 5.3.3-3.	5.3.3.3.3 para 2	R
34	CE Router PHB bandwidth allocation and negotiation needs to occur between the AR and the CE Router to prevent asymmetrical performance.	5.3.3.3.3 para 3	R
35	The CE Router bandwidth budget must be less than or equal to the AR bandwidth budget per queue.	5.3.3.3.3 para 4	R
36	Use of the Six-Queue model is required for routers that support it.	5.3.3.3.3 para 5	R
37	The same queuing model (six or four) shall be configured at both ends of the communication path to prevent asymmetrical performance.	5.3.3.3.3 para 6	R
38	If the router supports it, the six-queue model shall be configured on interfaces above T1.	5.3.3.3.3 para 7	R
39	The four-queue model shall be configured on interfaces T1 and below or on routers that do not support the six-queue model.	5.3.3.3.3 para 8	R
40	All CER and/or AR interfaces toward the CER shall support traffic conditioning on an aggregate granular service class basis on the input interface.	5.3.3.3.4 para 1	R
41	The system routers shall be able to traffic condition using IP addresses, protocol port numbers, and DSCPs as discriminators, as a minimum.	5.3.3.3.4 para 2	R
42	All CERs and/or AR interfaces toward the CER shall support traffic conditioning on a granular service class basis on the output interface.	5.3.3.3.4 para 3	R
43	All routers shall be capable of receiving, processing, and transmitting a voice packet within 2 ms or less in addition to the serialization delay for voice packets as measured from the input interface to output interface under congested conditions, as described in the UCR 2008, Change 3, Section 5.3.1.4.1.1, to include all internal functions.	5.3.3.4.1	R
The requirements below depict E2E engineering requirements. Due to variations in network architectures, these requirements cannot be accurately tested in a lab environment.			
44	The CE Segment supporting VVoIP shall ensure that the one-way latency from the IP handset to the CER within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions as averaged over any 5-minute period.	5.3.3.4.3 para 1	R
45	The CE Segment supporting VVoIP shall ensure that the one-way latency from the CER to the IP handset within the CE Segment is less than or equal to 35 ms (or less than or equal to 44 ms if the CER is collocated with an AR) for VVoIP sessions as averaged over any 5-minute or period.	5.3.3.4.3 para 2	R
46	The DISN network infrastructure supporting VVoIP shall ensure that the one-way latency from the CER to the CER across the DISN network infrastructure for F-F nodes does not exceed 150 ms (or 132 ms if the CER is collocated with an AR) for VVoIP as averaged over any 5-minute period.	5.3.3.4.4	R
47	The DISN network infrastructure supporting VVoIP shall ensure that the one-way jitter from the CER to the CER across the DISN Network Infrastructure for F-F nodes does not exceed 14 (or 10 ms if the CER is collocated with the AR) for VVoIP sessions during any 5-minute period.	5.3.3.5.3	R
48	The CE Segment supporting VVoIP shall ensure that the one-way jitter between the handset and CER within the Edge Segment does not exceed 3 ms (or 5 ms if the CER is collocated with an AR) for VVoIP sessions during any 5-minute period.	5.3.3.5.4	R
49	The DISN network infrastructure supporting VVoIP shall ensure that the one-way packet loss from the CER to the CER across the DISN network infrastructure for F-F nodes does not exceed 0.8 percent (or 0.3 percent if the CERs are collocated with the ARs) for VVoIP sessions as averaged over any 5-minute period.	5.3.3.6.3	R
50	The CE Segment supporting VVoIP shall ensure that the one-way packet loss between the handset and CER does not exceed 0.05 percent for VVoIP sessions as averaged over any 5-minute period.	5.3.3.6.4	R
51	The network infrastructure products supporting VVoIP shall accept, route, and process IPv6 protocol traffic while providing parity to IPv4.	5.3.3.10	R
52	The availability for the network infrastructure within the F-F from CER to CER shall be 99.96 percent or greater to include scheduled maintenance.	5.3.3.12.1 para 3	R

Table 3-1. CER Capability/Functional Requirements (continued)

ID	Requirement	UCR Reference	Required (R) Conditional (C)
53	The availability to include scheduled maintenance for the network infrastructure within a Customer Edge Segment, which includes ASLAN and EBC shall be 99.998 percent or greater for FO/F users, 99.996 percent or greater for I/P users, and 99.8 percent or greater for other users.	5.3.3.12.1 para 4	R
54	The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall have no single point of failure to include power sources and NM.	5.3.3.12.2 para 1	R
55	In the event of an E2E network infrastructure component failure in a network supporting VVoIP users with precedence above ROUTINE, all sessions that are active shall not be disrupted (i.e., loss of existing connection requiring redialing) and a path through the network shall be restored with 5 seconds.	5.3.3.12.2 para 3	R
56	No segment of the E2E network infrastructure shall use split cost metric routing for VVoIP traffic.	5.3.3.12.2 para 5	R
57	All network infrastructure products supporting VVoIP users with precedence above ROUTINE shall have 8 hours of backup power.	5.3.3.12.2 para 6	R
58	The E2E network infrastructure supporting VVoIP users with precedence above ROUTINE shall support a protocol that allows for dynamic rerouting of IP packets to eliminate any single points of failure.	5.3.3.12.3 para 1	R
59	All network infrastructure products supporting VVoIP users with precedence above ROUTINE used to meet the reliability requirements shall be capable of handling the entire session processing load in the event that its counterpart product fails.	5.3.3.12.3 para 2	R
60	All network infrastructure products supporting VVoIP that implement MPLS shall have a FRR capability that restores paths around a local failure (i.e., a failure involving a single router or circuit) within 50 ms.	5.3.3.12.3 para 3	R
61	Network infrastructure routers shall only enact switchovers based on a reduction in access network throughput or bandwidth with NM troubleshooting procedures, because the routers cannot determine where or what in the access IP connection is the cause of the reduction.	5.3.3.12.3 para 4	R
62	If the network infrastructure supports users with precedence above ROUTINE, then the network infrastructure routers shall provide an availability of 99.999 percent to include scheduled maintenance.	5.3.3.12.3 para 5	C
63	If the CER has at least two separate access connections (i.e., dual homed) and detects an access connection failure, the CER shall switch to the alternate or backup access connection using an automatic process and shall not require operator actions.	5.3.3.12.3 para 7	C
64	All F-F network infrastructure network connections supporting VVoIP shall have a bandwidth of T1 (1.544 Mbps) or greater.	5.3.3.12.4.1	R
65	The E2E network infrastructure (excluding session originators) supporting VVoIP sessions shall use the media default MTU. The media default MTU for Ethernet is 1500 bytes.	5.3.3.12.4.2 para 1	R
66	The E2E network infrastructure supporting VVoIP sessions shall permit packet fragmentation.	5.3.3.12.4.2 para 2	R
67	All E2E network infrastructure network connections consisting of Ethernet connections that support VVoIP shall be switched full-duplex connections.	5.3.3.12.4.2 para 5	R
68	All E2E network infrastructure product Ethernet interfaces shall support auto-negotiation as described in the IEEE 802.3 series of standards.	5.3.3.12.4.2 para 6	R
69	All E2E network system network links consisting of Ethernet connections that support VVoIP shall not exceed IEEE recommended distances for Ethernet cabling as shown in the UCR 2008, Change 3, Table 5.3.3-5.	5.3.3.12.4.2 para 6	R
70	The E2E Network Infrastructure supporting VVoIP shall assume the use of ITU-T G.711 (20 ms) for calculating bandwidth budgets within the fixed network even if compressed codecs are used.	5.3.3.13 para 1	R
71	The E2E network infrastructure design shall provide, at a minimum, a 25 percent increase in network capacity (i.e., throughput and number of sessions) above the current employed network capacity at all tandem switches, MFSs, MFSSs, and critical dual-homed EO switches and LSCs.	5.3.3.13 para 4	R
72	All Edge System routers supporting VVoIP shall support, as a minimum, the following routing protocols and methods: Static Routing, BGP-4, and IS-IS or OSPF.	5.3.3.14 para 1	R
73	The E2E network infrastructure shall provide a GOS of P.00 (i.e., zero sessions out of 100 will be “blocked” during the “busy hour”) for FLASH and FLASH OVERRIDE voice and video (VVoIP only) sessions.	5.3.3.15	R

Table 3-1. CER Capability/Functional Requirements (continued)

ID	Requirement	UCR Reference	Required (R) Conditional (C)
74	The E2E network infrastructure shall provide a GOS of P.02 (i.e., two sessions out of 100 will be blocked during the busy hour) and P.01, respectively, during a 100 percent increase above normal precedence usage for PRIORITY and IMMEDIATE voice and video (VVoIP only) sessions at a minimum.	5.3.3.15	R
75	The E2E network infrastructure supporting VVoIP shall provide a peacetime theater GOS of P.07 (i.e., seven voice sessions out of 100 will be blocked during the busy hour) or better, and an intertheater GOS of P.09 or better, as measured during normal business hours of the theaters for ROUTINE precedence voice and video (VVoIP only) sessions traversing the network from an EO or LSC EI and/or GEI.	5.3.3.15	R
76	No more than 15 percent of the B/P/C/Ss shall be affected by an outage in the network.	5.3.3.16	R

LEGEND:

AF	Assured Forwarding	IPv4	Internet Protocol version 4
AR	Aggregation Router	IPv6	Internet Protocol version 6
ASLAN	Assured Services Local Area Network	IS-IS	Intermediate System-Intermediate System
BGP	Border Gateway Protocol	ITU-T	International Telecommunication Union - Telecommunication Standardization Sector
B/P/C/S	Base/Post/Camp/Station		
C	Conditional	LSC	Local Session Controller
CER	Customer Edge Router	Mbps	Megabits per second
CM	Configuration Management	MFS	Multifunction Switch
DiffServ	Differentiated Services	MFSS	Multifunction Softswitch
DISA	Defense Information Systems Agency	MIB	Management Information Base
DISN	Defense Information System Network	MPLS	Multiprotocol Label Switching
DS1	Digital Signal Level 1 (1.544 Mbps) (2.048 Mbps European)	ms	millisecond
		MTU	Maximum Transmission Unit
DS3	Digital Signal Level 3	NM	Network Management
DSCP	Differentiated Services Code Point	NMS	Network Management System
E1	European Basic Multiplex Rate (2.048 Mbps)	OSPF	Open Shortest Path First
E2E	End-to-End	para	paragraph
EBC	Edge Boundary Controller	PE	Provider Edge
EF	Expedited Forwarding	PHB	Per Hop Behavior
EI	End Instrument	PM	Performance Management
EO	End Office	QoS	Quality of Service
F-F	Fixed-to-Fixed	R	Required
FCAPS	Fault, Configuration, Accounting, Performance, and Security	RFCs	Request for Comments
		SQF	System Quality Factors
FO-F	FLASH OVERRIDE/FLASH	SUT	System Under Test
FRR	Fast Re-Route	T1	Digital Transmission Link Level 1 (1.544 Mbps)
GEI	Generic End Instrument	TDM	Time Division Multiplexing
GOS	Grade of Service	UC	Unified Capabilities
I/P	IMMEDIATE/PRIORITY	VLAN	Virtual Local Area Network
IAW	in accordance with	VVoIP	Voice and Video over Internet Protocol
IEEE	Institute of Electrical and Electronics Engineers	WAN	Wide Area Network
IP	Internet Protocol		